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Research on the Differences in the Intention of Use of the Elderly to Different Smart Home-based Elderly Care Technology Based on TAM Model

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Abstract: *With the rapid development of "aging" and "informatization," many problems have arisen in using smart home-based elderly care technologies for the elderly. The attitude and the intention of use of the elderly to different technologies are different. This paper divides the smart home-based elderly care technologies into four categories: medical health technology, monitoring alarm technology, social communication technology, and entertainment learning technology. This paper explores the differences in the elderly's intention to use different technologies and the influencing factors based on the TAM model. The results show that for medical health technology, social communication technology, and entertainment learning technology, perceived usefulness is the most critical factor to affect the attitude and the intention of use. For the monitoring alarm technology, perceived ease of use is the most crucial factor affecting the attitude. Attitude is the most critical factor to affect the intention of use. Based on the above research conclusions, this paper puts forward some suggestions of orienting by the needs of the elderly, supported by aging-friendly renovation and developing research and development strategies by category.*

Keywords: *Population Aging, Smart Home-based Elderly Care Technology, Technology Acceptance Model, Intention of Use*

1. Introduction

According to "The Seventh National Population Census", the total population of the elderly aged 60 and above in China was 264 million by the end of 2020, accounting for 18.7% of the total population in China and representing an increase of 8.4 percentage points over 2000. China's aging population is becoming more and more serious. At the same time, with the development of the Internet, Chinese society has entered an era of a high-tech economy characterized by the digitization of information(Y. Jin & Zhao, 2019). While the"Silver hair" wave is becoming more and more intense, there has also been a wave of technological innovation across the country. Under such a social background, the industry of smart care for the aged has developed rapidly. The concept of smart care for the aged originated from the UK, whose core is to apply advanced information technology to provide comprehensive life services of the elderly and build a contact platform between the elderly and the government, communities, social groups, medical institutions and other subjects. Smart care for the aged in China started late and gradually formed during the development of smart cities(Wei, 2021). At present, **the** model of smart care for the aged in China mainly includes smart home care for the aged, smart medical care for the aged, smart institutional care for the aged, and smart city for the aged(Zhang & Han, 2017). Among them, the model of smart home care for the aged caters to the needs of the majority of Chinese elderly, which has the most significant practical effect(Y. He & Xing, 2020). Although the smart home-based elderly care technology can assist the elderly to solve some problems and difficulties in the aging process, the elderly often face difficulties trying to use products and services based on new technologies due to the large information technology gap(Ma & Chen, 2021).Therefore, this study selects the elderly in Kunming as the research object and classifies the smart home-based elderly care technologies to compare the differences between different technologies and put forward targeted suggestions.

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2. Theoretical Review and Model Assumptions

2.1. Theoretical Review

2.1.1 Classification of Smart Home-Based Elderly Care Technology

Most domestic and foreign research on smart care for the aged focuses on a specific technology, systems, or product services. Examples include mobile medical technology(Li, Jiang, Zhong, & Zeng, 2017), telecare systems(Su, Tsai, & Hsu, 2013), smartphones(J. He & Huang, 2020), wearable devices(J. Zhou & Zhou, 2021). In order to explore the differences in the elderly's intention to use different smart home care technologies, this paper first classifies these technologies. For example, Orlov L M and other scholars believe that smart home-based elderly care technologies include communication and engagement, home safety and security, health and wellness, learning, and contribution four categories(Orlov). Hu Chunping and other scholars classified the information technologies mainly needed by the elderly into health care technology, communication, and access to information-related technology(Hu, Chen, & Zheng, 2016). Based on the above classification criteria and the unique characteristics of the elderly in Kunming, this study divided the smart home-based elderly care technology into four categories: medical and health technology, monitoring and alarm technology, social communication technology, and entertainment learning technology.

2.1.2 TAM Theory

TAM (Technology Acceptance Model) is a model for studying the acceptance of information systems based on the Theory of Reasoned Action(Davis, 1989). It is found to be a model to explain better the behavior of the individuals who may be positively inclined towards a technology(Moon, Ji-Won, Kim, & Young-Gul, 2001) and is therefore chosen as the theoretical basis of this study(the TAM model is shown in Figure 1). In recent years, with the development and popularization of information technology, the model has been widely used in various fields (such as education(Chintalapati & Daruri, 2016), health care(Feng-Cheng et al., 2008)), different platforms and systems, (such as E-Payment Platform(Lai, 2017), E-Tax Systems(Soneka & Phiri, 2019)), different objects, (such as students(Tarhini, Hone, & Liu, 2013), seniors(M. Zhou et al., 2019),). Based on the technology acceptance model, this study compares the differences of the elderly's intention to use different smart home-based care elderly technologies and verifies the model's hypothesis again to enrich the research on the technology acceptance model in the field of elderly care.

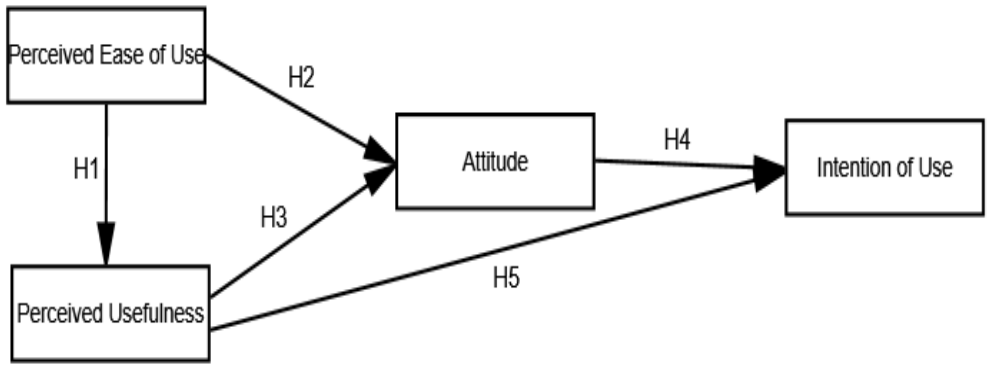

Figure 1: Technology acceptance model diagram

2.2. Model Assumptions

In this study, perceived ease of use (PEOU) means that older people think it is easy to learn and operate technology, to use technology to obtain information and solve problems. Perceived usefulness (PU) means that the technology can help seniors save time, increase efficiency and improve quality of life. Attitude (ATT) refers to the degree of pleasure and satisfaction of the elderly to use the technology. The intention of use (IU) refers to the elderly continuing to use and recommend the technology to others. Many scholars have tested the stability of the technology acceptance model through empirical studies (Plouffe, Hulland, & Vandenbosch, 2001; S. Taylor & P. A. Todd, 1995) and confirmed the relationship among variables (C. H. Jin, 2014; Pavlou & A, 2003). Based on the above research conclusions, this study proposed the following hypothesis (see Table 1).

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Table 1: TAM model assumptions for four types of technologies.

Technology Category	Hypothesis
Medical and Health Technology	H1: Older adults' perceived ease of use of medical and health technology positively influences their perceived usefulness. H2: Older adults' perceived ease of use of medical and health technology positively influences their attitude. H3: Older adults' perceived usefulness of medical and health technology positively influences their attitude. H4: Older adults' attitude of medical and health technology positively influence their intention of use. H5: Older adults' perceived usefulness of medical and health technology positively influences their intention of use.
Monitoring and Alarm Technology	H6: Older adults' perceived ease of use of monitoring and alarm technology positively influences their perceived usefulness. H7: Older adults' perceived ease of use of monitoring and alarm technology positively influences their attitude. H8: Older adults' perceived usefulness of monitoring and alarm technology positively influences their attitude. H9: Older adults' attitude of monitoring and alarm technology positively influence their intention of use. H10: Older adults' perceived usefulness of monitoring and alarm technology positively influences their intention of use.
Social Communication Technology	H11: Older adults' perceived ease of use of social communication technology positively influences their perceived usefulness. H12: Older adults' perceived ease of use of social communication technology positively influences their attitude. H13: Older adults' perceived usefulness of social communication technology positively influences their attitude. H14: Older adults' attitude of social communication technology positively influence their intention of use. H15: Older adults' perceived usefulness of social communication technology positively influences their intention of use.
Entertainment Learning Technology	H16: Older adults' perceived ease of use of entertainment learning technology positively influences their perceived usefulness. H17: Older adults' perceived ease of use of entertainment learning technology positively influences their attitude. H18: Older adults' perceived usefulness of entertainment learning technology positively influences their attitude. H19: Older adults' attitude of entertainment learning technology positively influence their intention of use. H20: Older adults' perceived usefulness of entertainment learning technology positively influences their intention of use.

3. Research Design

3.1. Survey Subjects

This survey was conducted between April and May 2021. Using the convenience sampling method, Chenggong District, Wuhua District, Guandu District, and Xishan District were selected in Kunming first. Then the random sampling method was used to select three communities in each District. Finally, we took the elderly in the selected community as the research object. The criteria for the research object were as follows: (1) age ≥ 60 years; (2) living in Kunming for six months or more; (3) no intellectual or language impairment; (4) have basic cognitive and judgmental skills. Finally, 612 older adults who met the criteria were included in this investigation.

3.2. Survey Method and Content

This study used the questionnaire survey method to collect data. The questionnaire was filled out by

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the respondents themselves. For some senior citizens or those with less education, one-to-one interviews were conducted, and the questionnaires were filled out by the investigators. To ensure the quality of the questionnaire, the questionnaire is designed based on the related research at home and abroad and combining with the characteristics of the elderly in Kunming. The questionnaire's content is divided into two parts: in the first part, basic information such as gender, age, education, and physical condition of the respondents was collected. In the second part, the latent variables related to the intention of use were measured, divided into four dimensions: perceived usefulness, perceived ease of use, attitude, and intention of use. The measurement items and references of each variable are shown in Table 2.

Table 2: Measurement items of variables.

Variables	Measurement Items	References
Perceived Ease of Use (PEOU)	PEOU1: Learning to operate the technology would be easy for me. PEOU2: The operation and use of the technology would be flexible. PEOU3: It is easy to obtain information through technology. PEOU4: It is easy to solve problems using technology.	(Davis, 1989)
Perceived Usefulness (PU)	PU1: Using the technology would save us time. PU2: Using technology can make us more efficient. PU3: Using the technology can improve the quality of life. PU4: Using technology will help me a lot in my life.	(Davis, 1989)
Attitude (ATT)	ATT1: Using the technology is a great idea. ATT2: The process of using the technology is enjoyable. ATT3: I'm satisfied with the technology.	(Shirley Taylor & Peter A Todd, 1995)
Intention of Use (IU)	IU1: I will continue to use the technology. IU2: I will recommend the technology to friends and family.	(Yu & Song, 2017)

3.3. Statistical Analysis Method

The data processing and analysis of this study were completed by SPSS19.0 and AMOS20.0 software. Firstly, SPSS19.0 software was used to conduct descriptive statistics on the basic information of the survey, test the reliability and validity of the questionnaire and carry out ANOVA analysis on the four types of techniques. Then AMOS24.0 software was used to verify and modify the TAM model.

4. Research Results

4.1. Descriptive Statistics

There were 612 questionnaires distributed in this study and 600 valid samples collected after eliminating the invalid questionnaires, with effective recovery of 98%. About 41.3% of the male and 58.7% of the female elderly participated in this survey. The age of the respondents mainly ranged from 60 to 69 years old, accounting for 45.3% of the total sample. In terms of education, most respondents have primary school or below, accounting for 50%. Concerning physical condition, about 50.7% of the elderly suffer from chronic diseases. About technical categories, the sample size of each technology category is 150, accounting for 25% of the total sample size. The basic information of this survey is shown in Table 3.

Table 3: Basic survey information

Statistical Content		Frequency	Percentage
Gender	Male	248	41.30
	Female	352	58.70
Age	60~69 Years	272	45.30
	70~79 Years	200	33.30
	80~89 Years	68	11.30
	≥90 Years	60	10.00

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Education	Primary school or below	300	50.00
	Junior high school	112	18.70
	Senior high school	112	18.70
	College degree or above	76	12.70
Physical Condition	Health	224	37.30
	Weak, chronic disease	304	50.70
	Disability	56	9.30
	Critical illness	16	2.70
Technical Classification	Medical and Health Technology	150	25.0
	Monitoring and Alarm Technology	150	25.0
	Social Communication Technology	150	25.0
	Entertainment Learning Technology	150	25.0

4.2. Reliability and Validity Analysis

First, the reliability is tested according to the Cronbach's Alpha coefficient of each variable. According to table 4, the coefficient values are all higher than 0.7, which indicates that the scale has high reliability. Then factor analysis was used to analyze convergent validity and discriminant validity. As shown from table 4, the AVE values of the four technologies of variables involved in this study are higher than 0. 5, which shows that sample data has good convergence validity. The square root of the AVE value of each variable is larger than its correlation coefficient with other variables, so it has higher discriminant validity(Li Jingz, Guan Ziyu, Xie Fei, & Qun, 2021). In summary, the reliability and validity tests of the questionnaire passed, and the results are shown in Table 4.

Table 4: Convergence and discriminant validity

Technical Classification	Variables	Convergent Validity		Discriminant Validity			
		Cronbach's Alpha	AVE	PU	PEOU	ATT	IU
Medical and Health Technology	PU	0.937	0.847	0.921	0.379	0.812	0.767
	PEOU	0.953	0.879	0.379	0.937	0.504	0.503
	ATT	0.875	0.8	0.812	0.504	0.894	0.869
	IU	0.831	0.856	0.767	0.503	0.869	0.925
Monitoring and Alarm Technology	PU	0.922	0.815	0.903	0.526	0.693	0.725
	PEOU	0.956	0.885	0.526	0.941	0.788	0.642
	ATT	0.843	0.761	0.693	0.788	0.872	0.834
	IU	0.836	0.86	0.725	0.642	0.834	0.928
Social Communication Technology	PU	0.924	0.816	0.903	0.762	0.845	0.75
	PEOU	0.952	0.874	0.762	0.935	0.823	0.785
	ATT	0.848	0.768	0.845	0.823	0.876	0.842
	IU	0.865	0.881	0.75	0.785	0.842	0.939
Entertainment Learning Technology	PU	0.928	0.824	0.908	0.822	0.826	0.761
	PEOU	0.957	0.886	0.822	0.941	0.832	0.806
	ATT	0.877	0.805	0.826	0.832	0.897	0.893
	IU	0.874	0.889	0.761	0.806	0.893	0.943

Note: The bold diagonal is the square root of AVE, and the lower triangle is the Pearson correlation.

4.3. Path Analysis and Hypothesis Testing

4.3.1 Model Fit Test and Correction

To verify the relationship among the latent variables, the fitting degree of the model was tested by using AMOS24.0 software. Taking medical health technology as an example, according to the estimated results of its initial model, the MI values of residual paths such as "E17 <-> E16", "E17 <-> E14", "E1 <-> E9" are large. Therefore, the initial model is modified by adding these residual paths, and the final results are shown in Table 5 (Models 1-4 represent the TAM models for medical and health technology, monitoring and alarm technology, social communication technology, entertainment learning technology, respectively). The goodness of fit indexes of the modified model all reach the best range, which shows that the model has a high degree of fit and can be used for further research. The revised model is shown in Figure 2.

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Table 5: Goodness-of-fit indicators in the structural model.

Measure	Threshold	Value				Source
		Model 1	Model 2	Model 3	Model 4	
CMIN/DF	＜3.0	1.182	1.133	1.109	1.125	(Hair, Tatham, Anderson, & Black, 2006)
CFI	>0.95 great	0.995	0.996	0.997	0.997	
GFI	>0.85 good	0.942	0.938	0.938	0.940	
AGFI	>0.8 good	0.904	0.906	0.903	0.904	
IFI	>0.9 good	0.995	0.996	0.997	0.997	
RMR	<0.09 good	0.034	0.025	0.023	0.029	
RMSEA	＜0.05 good	0.035	0.030	0.027	0.029	
PCLOSE	>0.05 good	0.768	0.840	0.862	0.843	

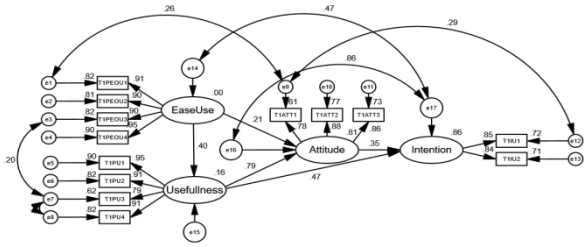

Figure 2. Modified tam model for medical and health technology

4.3.2 Path Analysis Results

After a proper model fitting, the relationship between the latent variables can be determined through path analysis. The results are shown in Table 6. The effects of different paths of each technique were compared vertically. Firstly, the impact of "perceived usefulness-> attitude" is much greater than that of "perceived ease of use-> attitude". At the same time, the effect of "perceived usefulness-> intention of use" was greater than that of "attitude-> intention of use". Secondly, for monitoring alarm technology, the effect of "perceived ease of use-> attitude" is much more significant than that of "perceived usefulness-> attitude". At the same time, the effect of "attitude-> intention of use" is far more significant than that of "perceived usefulness-> intention of use". Thirdly, for social communication technology, the effect of "perceived usefulness-> attitude" is greater than that of "perceived ease of use-> attitude". At the same time, the effect of "perceived usefulness-> intention of use" was greater than that of "attitude-> intention of use". Fourth, for the entertainment learning technology, the effect of "perceived usefulness-> attitude" is greater than that of "perceived ease of use-> attitude". At the same time, the effect of "perceived usefulness-> intention of use" was greater than that of "attitude-> intention of use".

4.3.3 Hypothesis Test Results

As can be seen from Table 6, p values of all paths corresponding to the TAM model of the four technologies are all less than 0.01, which shows that each independent variable has a significant influence on the dependent variable. Therefore, all hypotheses of this study have been verified.

Table 6: Path analysis and hypothesis verification

	Path		Model 1	Model 2	Model 3	Model 4	Hypothesis
Perceived usefulness	<---	perceived ease of use	0.402***	0.541***	0.803***	0.872***	H1, H6, H11, H16 Supported
Attitude	<---	perceived ease of use	0.210***	0.607***	0.454***	0.457***	H2, H7, H12, H17 Supported
Attitude	<---	Perceived usefulness	0.795***	0.429***	0.565***	0.515***	H3, H8, H13, H18 Supported
intention of use	<---	Attitude	0.354***	0.742***	0.492***	0.476***	H4, H9, H14, H19 Supported
intention of	<---	Perceived	0.469***	0.263**	0.559***	0.521***	H5, H10, H15,

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use	usefulness	H20 Supported

Note: ***p<0.001, **p<0.01, *p<0.05.

5. Conclusion and Suggestion

5.1. Conclusion

5.1.1. Analysis from the Overall Perspective of Technology

Firstly, the smart home-based elderly care technology's perceived usefulness is generally good, which is higher than the perceived ease of use. Secondly, the attitude and the intention of use for elderly to use smart home-based elderly care technology are generally good, but there are some differences between different technologies. Thirdly, the perceived usefulness is the most critical factor influencing the attitude and intention of use for the elderly.

5.1.2. Comparative Analysis of Different Technologies

Firstly, for medical and health technology, social communication technology, and entertainment and learning technology (especially medical and health technology), perceived usefulness is the most critical factor to affect the old people's attitude. Therefore, positive attitudes can be promoted by increasing the perceived usefulness of technology in the elderly. Perceived usefulness is the most crucial factor that affects the intention of use. Secondly, for monitoring and alarm technology, the effect of the two paths is opposite. Perceived ease of use is the most critical factor affecting the attitude of the elderly. At the same time, attitude is the most critical factor to affect the intention of use for the elderly to use the monitoring and alarm technology.

5.2. Suggestion

5.2.1. Improve Perceived Usefulness By Taking Subject Demand As Guidance

Before the innovation of the technology and the development of the products, relevant enterprises should take complete account of the physiological and psychological needs of the elderly to improve their perceived usefulness of the technology and products. As a particular group in society, the needs of the elderly are unique at the same time. It is not always a good experience for the elderly to increase the function of the products blindly. On the contrary, simplifying the secondary products and processes appropriately will help the elderly reduce the memory and operation burden and improve the perceived usefulness of the products. For major core products and functions, new modules can be added appropriately according to user characteristics. At the same time, the enterprises should pay attention to the after-sales survey records and listen to the valuable advice of the elderly to guide their future research and development work.

5.2.2. Improve Perceived Ease of Use With Age-Appropriate Retrofitting as the Key

After determining the research and development direction of the related technology and products, the enterprise should focus on the specific research and development process. At this time, perceived ease of use should be taken as the primary basis of design. According to the living habits and social background of the elderly, the suitable products and functions are designed, the operation procedures are simplified, the operation pages are rationally arranged to ensure that the products are easy to learn and use. At the same time, enterprises can cooperate with the local government or community to set up schools or training courses for the elderly. After that, the ability of the elderly to use intelligent technologies will be improved, which will fundamentally solve the "digital divide" faced by the elderly and effectively enhance their sense of happiness and participation in the development of informatization.

5.2.3. Based on the Technology Category, the Research and Development Strategy is Formulated by Classification.

When developing new smart home-based elderly care technologies, enterprises should pay attention to the complex impact caused by technological differences and formulate research and development strategies based on categories and priorities. According to the results of this study, for medical health technology, social communication technology, and entertainment learning technology, we should pay attention to the design of practical functions. Designing products based on the actual needs of the elderly improve their perception of usefulness and improves their positive attitude and intention of use.

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While about the monitoring and alarm technology, the enterprises should focus on improving the products' ease of use. Designing products with simple operation through technological innovation effectively solves the problem that the elderly are difficult to use intelligent technology. After that, they can reverse negative attitudes and increase the intention of use by improving perceived ease of use.

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